

Topic Test

Summer 2022

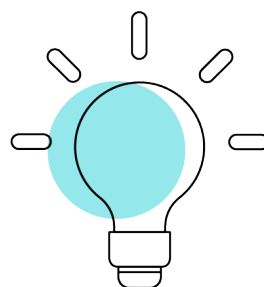
Pearson Edexcel GCE Mathematics (9MA0)

Paper 3 – Statistics

Topic 1: Regression lines (change of variable); hypothesis test for correlation

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Mark Scheme

Question T1_Q1

Qu 2	Scheme	Marks	AO
(a)	$H_0 : \rho = 0$ $H_1 : \rho < 0$ Critical value: -0.6215 (Allow any cv in range $0.5 < cv < 0.75$) $r < -0.6215$ so significant result and there is evidence of a negative correlation between w and t	B1 M1 A1 (3)	2.5 1.1a 2.2b
(b)	e.g. As temperature increases people spend more time on the beach and less time shopping (o.e.)	B1 (1)	2.4
(c)	Since r is close to -1 , it is consistent with the suggestion	B1 (1)	2.4
(d)	t will be the explanatory variable since sales are likely to depend on the temperature	B1 (1)	2.4
(e)	Every degree rise in temperature leads to a drop in weekly earnings of £171	B1 (1)	3.4
(7 marks)			
Notes			
(a)	B1 for both hypotheses in terms of ρ M1 for the critical value: sight of ± 0.6215 or any cv such that $0.5 < cv < 0.75$ A1 must reject H_0 on basis of comparing -0.915 with -0.6215 (if $-0.915 < 0.6215$ is seen then A0 but may use $ r $ o.e. which is fine) <u>and</u> mention “negative”, “correlation/relationship” and at least “ w ” and “ t ”		
(b)	B1 for a suitable <u>reason to explain</u> negative correlation using the context given. e.g. “As temperature drops people are more likely to go shopping (than to the beach)” e.g. “As temperature increases people will be outside rather than in shops” A mere description in context of negative correlation is B0 SO e.g. “As temperature increases people don’t want to go shopping/buy clothes” is B0 e.g. “Less clothes needed as temp increases” is B0		
(c)	B1 for a suitable reason e.g. “strong”/”significant”/”near perfect” “correlation”, $ r $ close to 1 <u>and</u> saying it is consistent with the suggestion. Allow “yes” followed by the reason.		
(d)	B1 For identifying t <u>and</u> giving a suitable reason. Need idea that “ w <u>depends</u> on t ” <u>or</u> “ w <u>responds</u> to t ” <u>or</u> “ t <u>affects</u> w ” (o.e.) Allow t (temperature) <u>affects</u> the other variable etc Just saying “ t is the independent variable” <u>or</u> “ t <u>explains</u> change in w ” is B0 N. B. Suggesting causation is B0 e.g. “ t causes w to decrease”		
(e)	B1 for a description that conveys the idea of rate per degree Celsius. Must have 171, condone missing “£” sign.		

Question T1_Q2

Question	Scheme		Marks	AOs
3(a)	$H_0 : \rho = 0 \qquad H_1 : \rho > 0$		B1	2.5
	Critical value 0.3438		M1	1.1a
	(0.446 > 0.3438) so there is evidence that the product moment correlation coefficient (pmcc) is greater than 0/there is positive correlation		A1	2.2b
			(3)	
(b)	The value is close(r) to 1 or there is strong(er) (positive) correlation		B1	2.4
			(1)	
(c)	$\log_{10} y = -1.82 + 0.89(\log_{10} x)$	$y = ax^n \rightarrow$ $\log_{10} y = \log_{10} (ax^n)$	M1	1.1b
	$y = 10^{-1.82+0.89(\log_{10} x)}$	$\log_{10} y = \log_{10} a + \log_{10} x^n$	M1	2.1
	$y = 10^{-1.82} \times 10^{0.89(\log_{10} x)}$ [$= 10^{-1.82} \times 10^{(\log_{10} x)^{0.89}}$]	$\log_{10} y = \log_{10} a + n \log_{10} x$ [$\log_{10} a = -1.82, n = 0.89$]	M1	1.1b
	$y = 0.015x^{0.89}$	$y = 0.015x^{0.89}$	A1A1	1.1b 1.1b
			(5)	
	(9 marks)			
Notes				
(a)	B1: for both hypotheses correct in terms of ρ M1: for the critical value: sight of 0.3438 or any cv such that $0.25 < cv < 0.45$ A1: a comment suggesting a significant result/ H_0 is rejected on the basis of <u>seeing</u> +0.3438 and which mentions “pmcc/correlation/relationship” and “greater than 0/positive” (not just $\rho > 0$) or an answer in context e.g. ‘as “income”(o.e.) increases, “CO ₂ /emissions”(o.e.) increases’ A contradictory statement scores A0 e.g. ‘Accept H_0 , therefore positive correlation’			
(b)	B1: for suitable reason e.g. r is close(r) to 1 or “strong(er)”/“near perfect” “correlation” Do not allow ‘association’			
(c)	For both methods, once an M0 is scored, no further marks can be awarded and condone missing base 10 throughout Method 1: (working to the model) M1: Correct substitution for both c and m (may be implied by 2 nd M1 mark) M1: Making y the subject to give an equation in the form $y = 10^{a+b(\log_{10} x)}$ (may be implied by 3 rd M1 mark) M1: Correct multiplication to give an equation in the form $y = 10^a \times 10^{b(\log_{10} x)}$ (this line implies M1M1M1 provided no previous incorrect working seen)			
	Method 2: (working from the model) M1: Taking the log of both sides (may be implied by 2 nd M1 mark) M1: Correct use of addition rule (may be implied by 3 rd M1 mark) M1: Correct multiplication of power (this line implies M1M1M1 provided no previous incorrect working seen) A1: $n = 0.89$ or $a = \text{awrt } 0.015$ or $y = ax^{0.89}$ or $y = \text{awrt } 0.015x^n$ (dep on M3) A1: $n = 0.89$ and $a = \text{awrt } 0.015$ / $y = \text{awrt } 0.015x^{0.89}$ (dep on M3) do not award the final A1 if answer is given in an incorrect form e.g. $y = 0.015 + x^{0.89}$			

Question T1_Q3

Qu 2	Scheme	Marks	AO
(a)	Negative	B1 (1)	1.2
(b)(i)	Rainfall	B1	2.2b
(ii)	mm <u>or</u> hPa or Pascals or hectopascals or mb or millibars	B1ft (2)	1.1b
(c)	$H_0 : \rho = 0$ $H_1 : \rho \neq 0$ Critical value: $-0.361(0)$ $r < -0.3610$ so significant result and there is evidence of a correlation between Daily Total <u>Sunshine</u> and Daily Maximum Relative <u>Humidity</u>	B1 M1 A1 (3)	2.5 1.1b 2.2b
(d)	Humidity is high and there is evidence of correlation and $r < 0$ So expect amount of sunshine to be <u>lower</u> than the <u>average</u> for Heathrow(oe)	B1 (1)	2.2b
		(7 marks)	
Notes			
(a)	B1 for stating negative. “Negative skew” is B0 though		
(b)(i)	B1 for mentioning “rainfall” (allow “rain” <u>or</u> “precipitation”) <u>or</u> “pressure” (if more than 1 answer both must be correct) NB the other quantitative variable for Perth is: Daily Mean Wind Speed and scores B0 [Not allowed “wind speed” since $r = +0.15$ and in winter might expect wind to raise temp]		
(ii)	B1ft for giving the correct units. If Daily Mean Wind Speed (kn) or knots “Wind speed” and “knots” would score B0B1 but any other variable scores B0B0		
(c)	B1 for both hypotheses correct in terms of ρ M1 for the correct critical value compatible with their H_1 : allow $\pm 0.361(0)$ If the hypotheses are 1-tail then allow cv of ± 0.3061 e.g. Alternative hypothesis with $r < \pm 0.377$ implies a one-tail test <u>or</u> H_0 and H_1 in words saying “ H_0 : there is no correlation, H_1 : there is correlation” is two-tail If there are no hypotheses (or they are nonsensical) assume 2-tail so M1 for $\pm 0.361(0)$ A1 for a correct conclusion in context based on comparing -0.377 with their cv. Condone incorrect inequality e.g. $-0.3610 < -0.377$ as long as they reject H_0 Do not accept contradictory statements such as “accept H_0 so there is evidence of ...” Can say “support for Stav’s <u>belief</u> ”(o.e.e.g. “claim”) or “evidence of a correlation between <u>sunshine</u> and <u>humidity</u> ” condone “negative correlation” or comments such as “if humidity is high amount of sunshine will be low”		
(d)	B1 for stating <u>low</u> amount of sunshine (o. e.) and some reference to $r < 0$ or fog Check for the following 2 features: (i) low sunshine: allow ≤ 5 hrs (LDS mean for 2015 is 5.3, humidity 97% is 4.1, $\geq 97\%$ is 3.1) (ii) negative correlation may be described in words e.g. “high humidity gives low sunshine” <u>or</u> fog (LDS says $>95\%$ humidity is foggy) so less sunshine		

Question T1_Q4

Qu 2	Scheme	Marks	AO
(a)	Negative	B1 (1)	1.2
(b)	Marc's suggestion <u>is compatible</u> because it's <u>negative correlation</u>	B1 (1)	2.4
(c)	$(r =) - 0.54458266...$ awrt <u>-0.545</u>	B1 (1)	1.1b
(d)	$H_0 : \rho = 0$ $H_1 : \rho < 0$ [5% 1-tail cv =] $(\pm) 0.4259$ (significant result / reject H_0) There <u>is</u> evidence of negative <u>correlation</u> between the <u>number of letters</u> in (or <u>length</u> of) a student's last <u>name</u> and their first <u>name</u>	B1 M1 A1 (3)	2.5 1.1a 2.2b
		(6 marks)	
Notes			
(a)	B1 for “negative” Allow “slight” or “weak” etc Allow a description e.g. “as x increases y decreases” or in context e.g. “people with longer last names tend to have shorter first names” A comment of “negative skew” is B0 Need to see distinct or separate responses for (a) and (b)		
(b)	B1 for a comment that suggests data is compatible with the suggestion and a suitable reason such as “there is negative correlation” <u>or</u> a description in x and y or in context <u>or</u> the points lie close to a line with <u>negative gradient</u> <u>or</u> draw line $y = x$ and state that <u>more points below the line</u> so <u>supports (or is compatible with)</u> his suggestion A reason based on just a single point is B0 e.g. “ 11 letters in last name has only 5 in first name”		
(c)	B1 for awrt $- 0.545$		
(d)	B1 for both hypotheses correct in terms of ρ M1 for a critical value compatible with their H_1 : 1-tail: awrt ± 0.426 (condone ± 0.425) or 2-tail (B0 scored for H_1) : awrt ± 0.497 If hypotheses are in words and can deduce whether one or two-tail then use their words. If no hypotheses or their H_1 is not clearly one or two tail assume one-tail A1 for compatible signs between cv and r and a correct conclusion in context mentioning <u>correlation</u> and <u>number of letters</u> or <u>length</u> and <u>name</u> (ft their value from (c)) Do NOT award this A mark if contradictory comments or working seen e.g. “accept H_0 ” or comparison of 0.426 with significance level of 0.05 etc NB The M1A1 can be scored independently of the hypotheses		